

# The NISUS Magnet Diagnostic

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## Abstract

This paper presents the detailed design of the diagnostic “pop-ins,” a description of their use for FEL operation, examples of data obtained, results of reproducibility studies, and a description of associated external diagnostic components. The Near Infrared Scalable Undulator System (NISUS) is a 10-meter-long undulator magnet that serves as the radiator section of the Deep Ultraviolet Free Electron Laser (DUVFEL) currently in operation at BNL’s, Source Development Laboratory (SDL) in the NSLS department. The NISUS undulator requires extensive diagnostic capability to assure generation of SASE light for nonseeded or seeded operation with the anticipated upgrade to high-gain harmonic generation (HGHG). The design of the e-beam and laser in-vacuum diagnostics was challenging due to the fact that all of the sensing components resided in the undulator’s gap and had to be compatible with an existing vacuum chamber. Budget constraints and the required quantity (18) made a highly reliable, multifunctional, economic design paramount. The pop-in monitors are novel, low-cost, in-vacuum diagnostic devices that perform the following functions: laser alignment, e-beam trajectory, e-beam position, and e-beam profile monitoring using visible YAG and OTR emission, emittance measurement, and FEL light sampling. The reproducibility of  $\pm 1$  CCD pixel with a resolution of 9 microns has been achieved. Using these devices, operators were able to achieve SASE operation in record time.

**Keywords:** SDL, NISUS, SASE, diagnostic, pop-in monitors

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